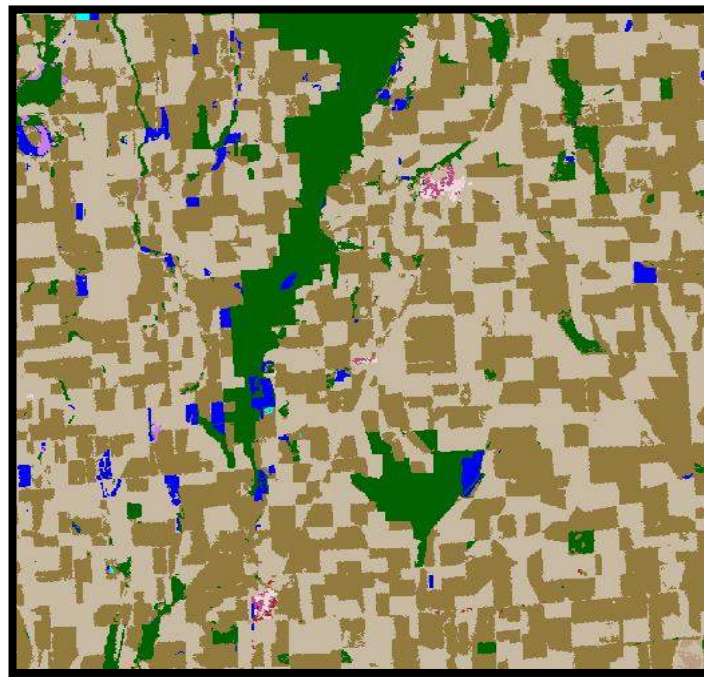
Crop Acreage Estimation: Landsat TM and Resourcesat-1 AWiFS Sensor Assessment of the Mississippi River Delta, 2005



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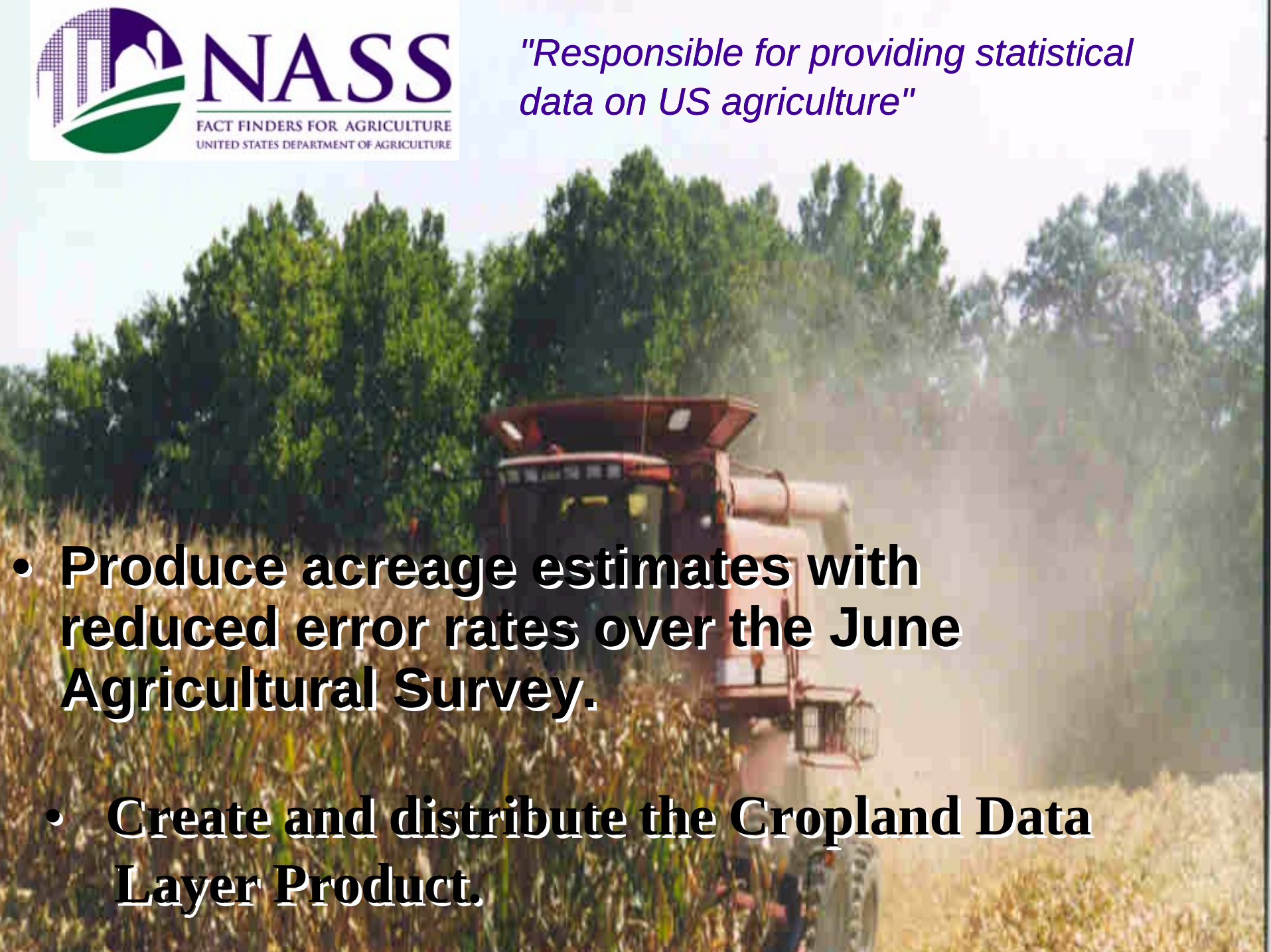
703-877-8000
claire_boryan@nass.usda.gov

NASS
FACT FINDERS FOR AGRICULTURE
UNITED STATES DEPARTMENT OF AGRICULTURE

"Responsible for providing statistical data on US agriculture"



- **Produce acreage estimates with reduced error rates over the June Agricultural Survey.**
- **Create and distribute the Cropland Data Layer Product.**

2001 Wildlife Damage Survey

Released March 13, 2002 by the Maryland Agriculture Statistics Service a cooperative service of the Maryland Department of Agriculture, and the National Agricultural Statistics Service. For more information call (410)-841-5740.

7.7 Pecent of Crop Value Lost to Deer and Geese

Maryland farmers lost $17.2 million of corn, soybeans and wheat to deer or geese during 2001. This translates to Maryland farmers losing 7.7 percent of the crop value to deer and geese. Soybeans accounted for the greatest economic loss, totaling $9.1 million, 11 percent. Corn losses were $6.6 million, 5.8 percent and wheat $1.5 million, 5.6 percent. Deer damage resulted in losses of $13.6 million, 6.1 percent, while geese losses were $3.6 million, 1.6 percent.

Production losses totaled 6.0 million bushels. Corn losses were 3.2 million bushels, soybean losses totaled 2.2 million bushels and wheat accounted for 0.6 million bushels. Production losses to deer were 4.7 million bushels and geese 1.3 million bushels.

In terms of yield, losses to deer were most severe in Central and Western Maryland, while geese damage was greater on the Eastern Shore. Corn yield losses of 9.6 bushels per acre and 7.4 bushels per acre were reported in Central and Western Maryland, respectively. The Lower Eastern Shore reported the highest soybean losses of 6.1 bushels per acre.

Sixty-two percent of farms reported deer or geese damage to one or more crop. Damage was reported on 61 percent of farms raising corn, 58 percent of farms growing soybeans and 27 percent of farms with wheat.

Maryland 2001 Crop Loss from Deer

Region1	Crop	Acres Harvested	Harvested Yield (bu/acre)	Average Yield Loss (bu/acre)	Production Loss (bu)	Economic Loss ($)
Western Maryland	Corn	5,500	104.9	7.4	40,700	83,435
Allegany, Garrett	Soybeans	300	36.7			
	Wheat	200	45.0	2.3	460	1,127
Central Maryland	Corn	125,200	98.2	9.6	1,201,920	2,463,936
Baltimore, Carroll, Frederick, Harford,	Soybeans	92,500	34.0	3.9	360,750	1,479,075
Howard, Montgomery, Washington	Wheat	38,300	63.3	3.3	126,390	309,656
Southern Maryland	Corn	29,800	132.7	4.9	146,020	299,341
Anne Arundel, Calvert, Charles,	Soybeans	43,200	38.0	3.3	142,560	584,496
Prince Georges, St. Mary's	Wheat	16,000	57.0	0.9	14,400	35,280
Upper Shore	Corn	157,000	159.2	5.1	800,700	1,641,435
Cecil, Caroline, Kent,	Soybeans	232,000	39.9	2.4	556,800	2,282,880
Queen Anne's, Talbot	Wheat	86,500	64.0	1.1	95,150	233,118
Lower Shore	Corn	92,500	150.7	4.1	379,250	777,463
Dorchester, Somerset,	Soybeans	147,000	41.0	6.1	896,700	3,676,470
Wicomico, Worcester	Wheat	34,000	63.0	0.9	30,600	74,970
Maryland	Corn	410,000	136.0	6.4	2,624,000	5,379,200
	Soybeans	515,000	39.0	3.6	1,854,000	7,601,400
	Wheat	175,000	63.0	1.5	262,500	643,125
	All Crops				4,740,500	13,623,725

Wisconsin Agricultural Statistics Service
P.O. Box 8934 Madison, WI 53708-8934
In cooperation with WI Department of Agriculture, Trade and Consumer Protection

USDA

2002 Dairy Producer Opinion Survey

November 2002

Wisconsin Milk Production To Recover

Milk production is expected to increase in Wisconsin during the next five years according to a survey conducted by the Wisconsin Agricultural Statistics Service. This statewide survey of producers asked for their plans with the assumption that milk prices for the next five years will be at the same level as the past five years. The survey was conducted during May and June 2002.

Based on the survey, 60 percent of producers expect to keep the same herd size, 20 percent plan to increase herd size, and 20 percent intend to discontinue milking by 2007. Actual results will depend on future milk prices, input prices, financing availability, crop yields, and other factors.

The number of herds projected for 2007 shows that the diversity of small to large herds will continue. The most prevalent herd size will remain at 50 to 99 cows.

All Milk Price, Wisconsin
Annual Average, 1980 - 2002 1/

1/For 2002, price is January-September average.

Wisconsin Dairy Herds by Herd Size

Milk cow herd size	May 2002 herds	May 2007 herds (projected) 1/	Change 2007/2002
	Number		Percent
1 - 29	2,800	1,440	-45
30 - 49	4,700	3,440	-27
50 - 99	7,400	5,600	-24
100 - 199	1,900	2,080	+9
200 - 499	700	900	+29
500+	200	440	+120
Total	17,500	13,900	-20

1/The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

Wisconsin Dairy Farmer Plans for May 2007 1/ by Herd Size

Milk cow herd size	Herds	Keep same herd size	Increase herd size	Discontinue milking
	Number	Percent		
1 - 29	2,800	47	17	36
30 - 49	4,700	71	9	20
50 - 99	7,400	63	19	18
100 - 199	1,900	53	37	10
200 - 499	700	33	59	8
500+	200	22	78	0
Total	17,500	60	20	20

1/The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

Percent of Herds by Size Group
2007 Projection

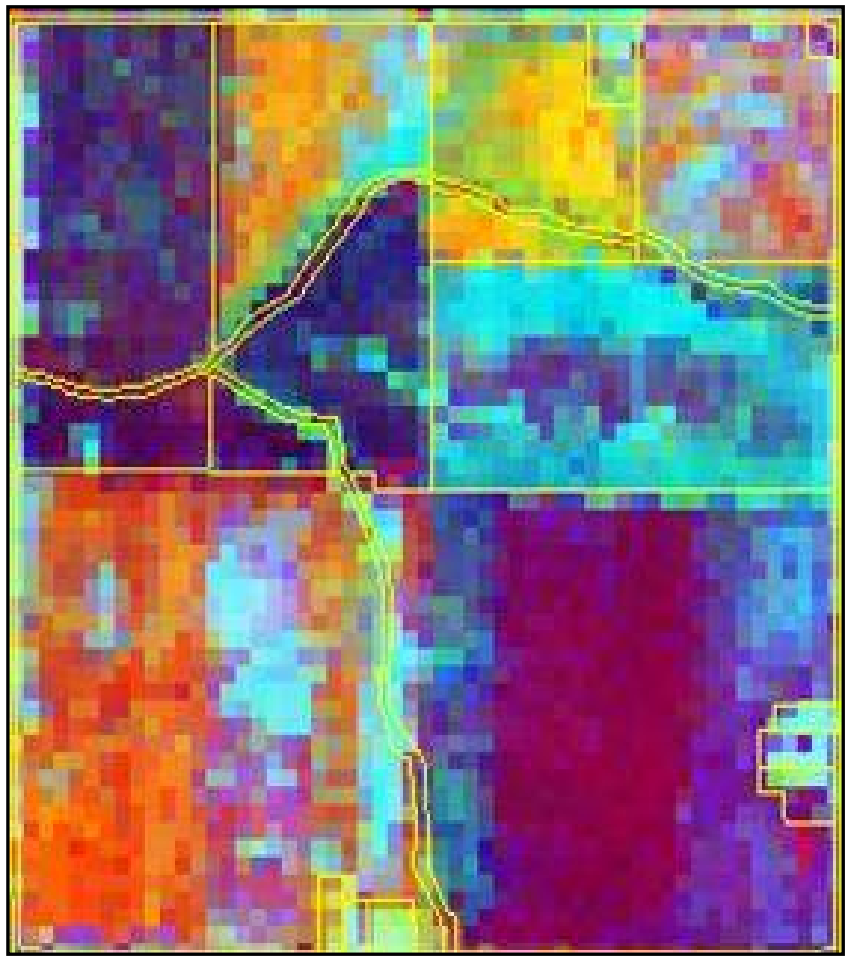
Background on the Cropland Data Layer

- June Agricultural Survey (JAS) – National in Scope
  - 41,000 farms visited
  - 11,000 one-square mile sample area segments visited
  - Most states contain between 150 – 400 segments
  - Planted acreage estimate
- Cropland Data Layer depends on the JAS data
  - Unbiased statistical estimator of crop area
    - State and county level estimates

Segments

Enumerated

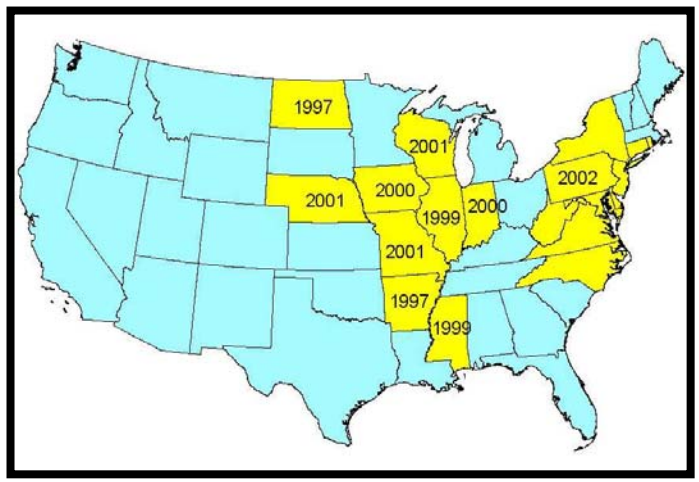
Digitized



Purpose of the Cropland Data Layer

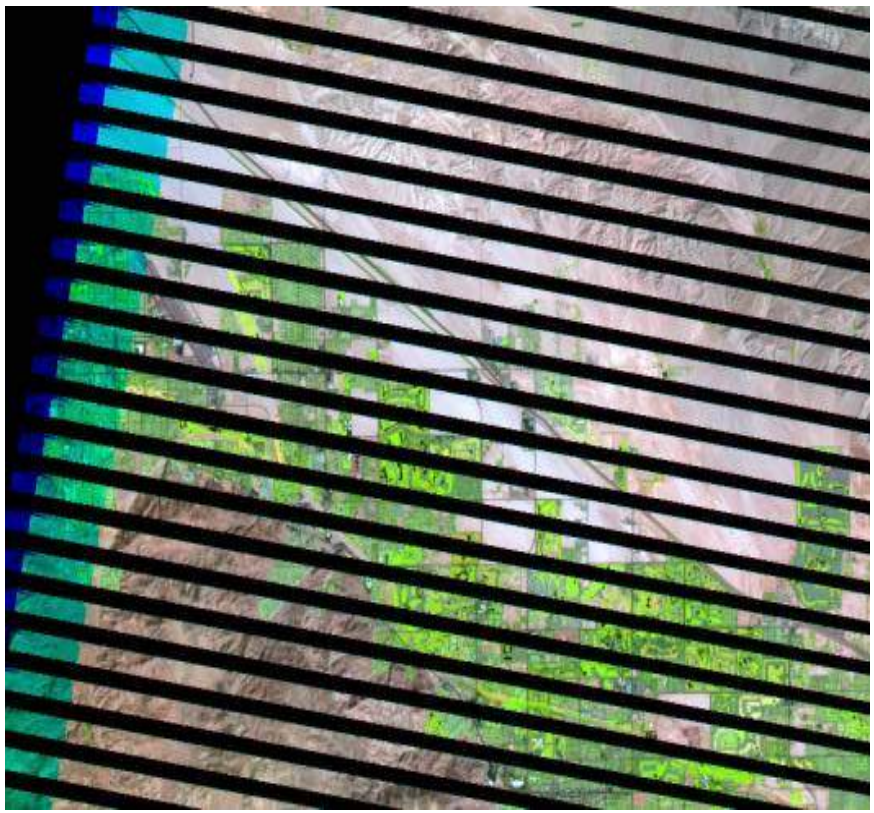
1. Combine remote sensing imagery and NASS survey data to produce *supplemental* acreage estimates for the state's major commodities

2. Production of a crop-specific digital land cover data layer for distribution in industry standard GeoTiff format



The Landsat Data Gap

Landsat 7 ETM+



Landsat 5 TM

USGS
science for a changing world

News Release

November 30, 2005 Ron Beck

Landsat 5 Experiencing Technical Difficulties

On November 26, 2005, the back-up solar array drive on Landsat 5 began exhibiting unusual behavior. The solar array drive maintains the proper pointing angle between the solar array and the sun. The rotation of the solar array drive became sporadic and the solar array was not able to provide the power needed to charge the batteries. Maintaining power to the batteries is critical to sustain proper operation of the spacecraft. The primary solar array drive failed under similar circumstances last January. As a result of this current situation, imaging operations will be suspended for at least the next two weeks or until attempts to solve the problem have been resolved.

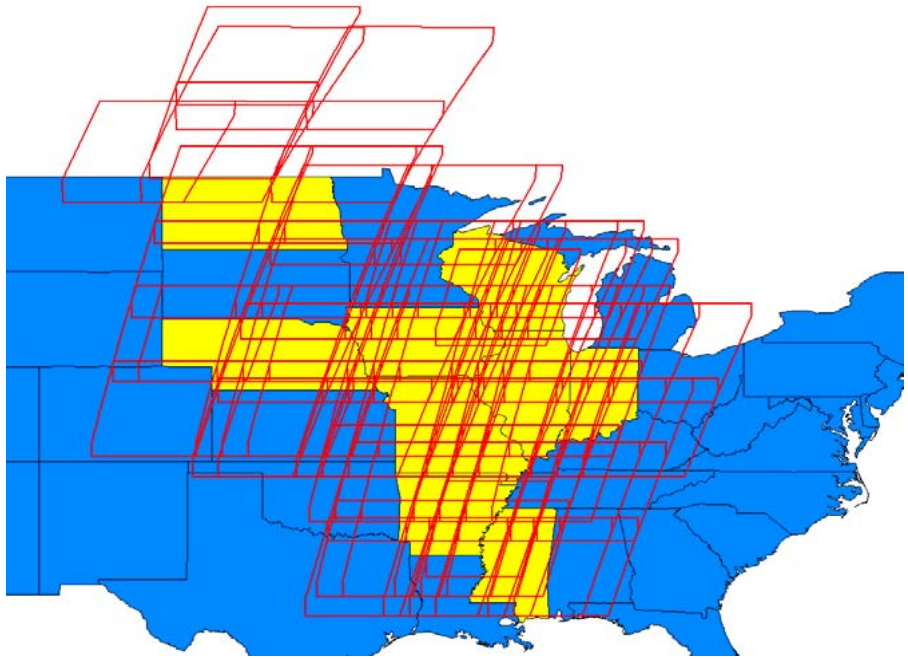
Source: USGS, Landsat Project:
http://landsat.usgs.gov/slc_enhancements/slc_off_level1_standard.php

Indian Remote Sensing Satellite: RESOURCESAT-1

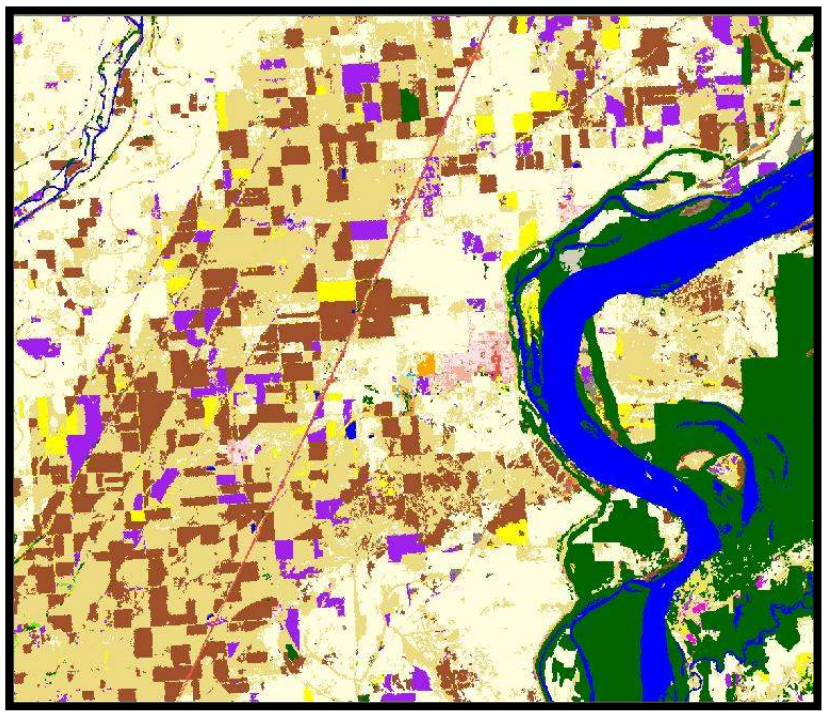
Advanced Wide Field Sensor (AWiFS)

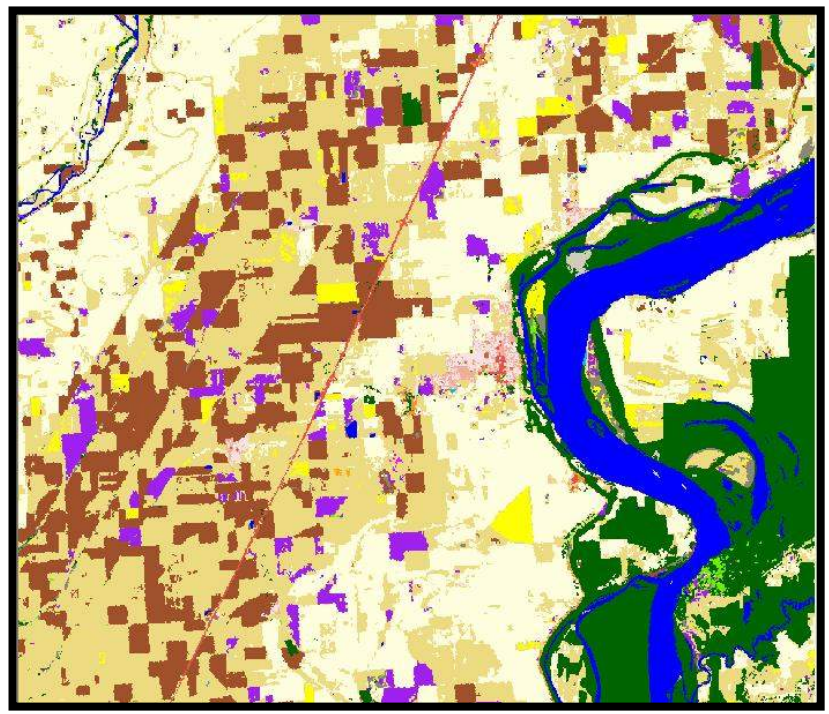
States Targeted for Data Collection

- AWiFS: Swath: 370 km each head, 740 km combined, 56 m resolution at nadir, 70 m resolution at field edges.
- **Spectral Bands**
- **B2: 0.52-0.59 (Visible Green)**
- **B3: 0.62-0.68 (Visible Red)**
- **B4: 0.77-0.86 (Near Infrared**
- **B5: 1.55-1.70 (Middle infrared)**



Mississippi River Delta 2005
Cropland Classifications
using Classification Tree Analysis
(See5)



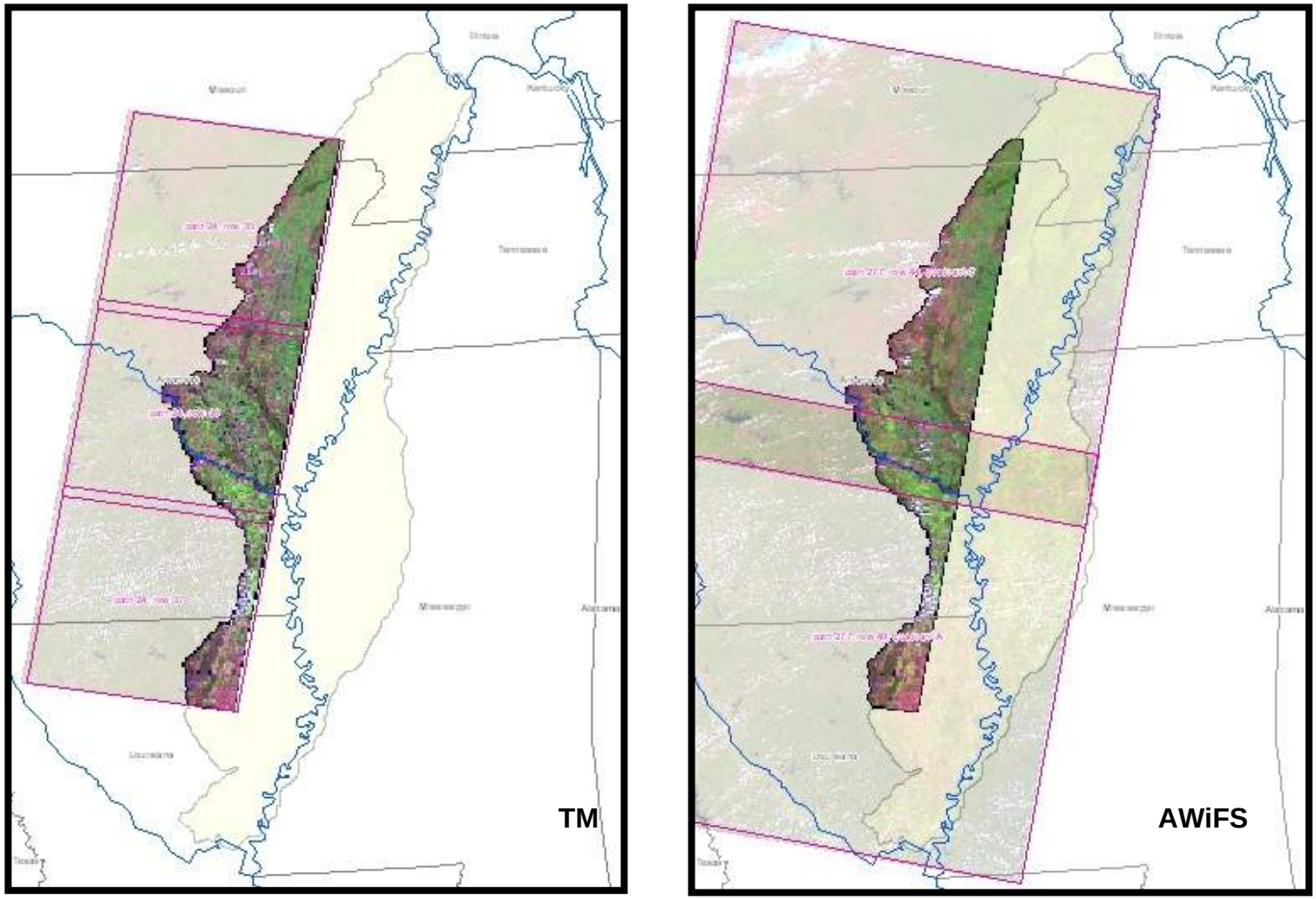


Corn
Cotton
Rice
Sorgum
Soybean
Winter Wheat
Wheat/Soybean Double Crop
Fallow
Aquaculture
Pasture
Woodland
Urban
Water

Landsat-5 TM

AWiFS

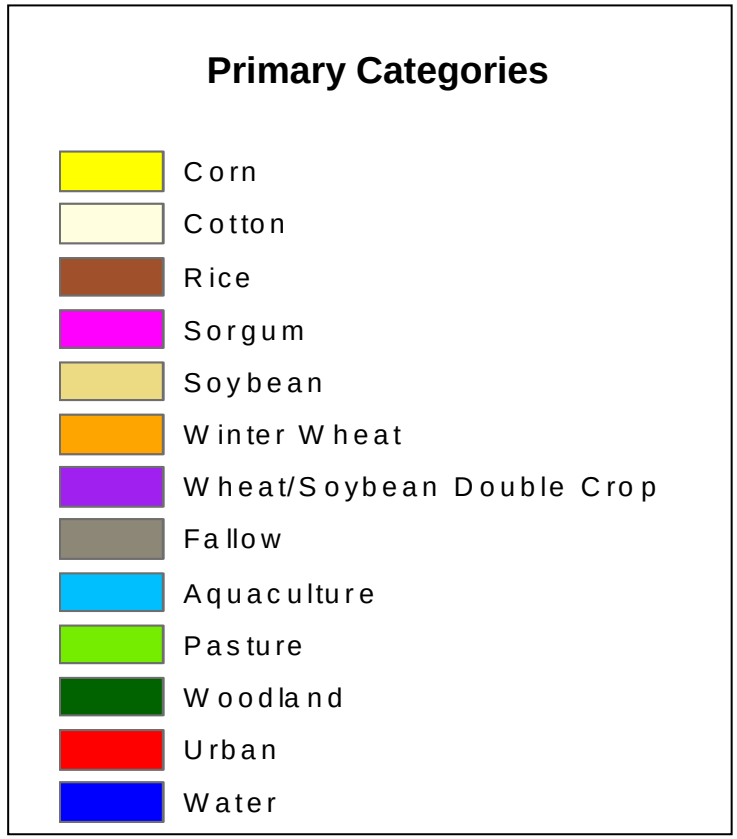
Analysis of coincident TM and AWiFS imagery



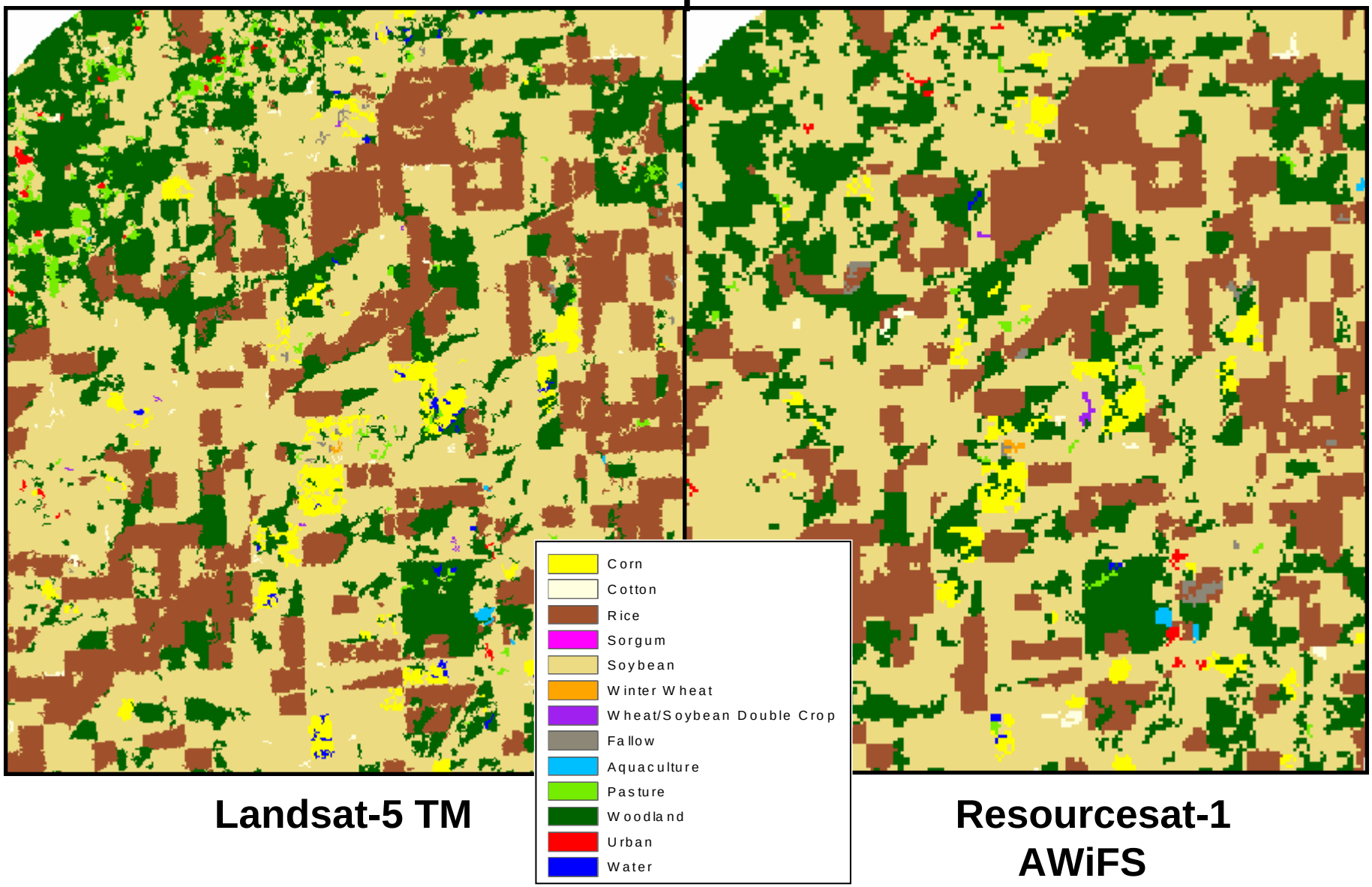
August 20, 2005 - Landsat-5 and Resourcesat-1 acquired same date imagery over Arkansas including the agriculturally intensive region of the Mississippi River Delta

Coincident Landsat TM and AWiFS cropland classifications

- Imagery clipped to identical extent
- TM imagery analyzed at 30m, AWiFS at 56m resolution
- 2,000 (approx) randomly distributed polygons (100,000 acres) used for ground truth and validation from JAS 2005 survey
- Classification tree analysis (See5) performed
- Minimum mapping unit of 5 pixels applied



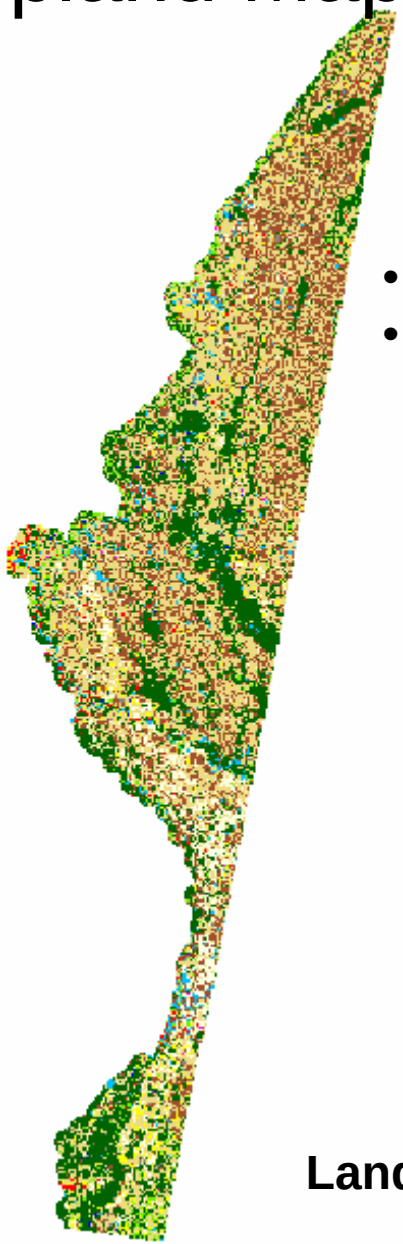
Subset example of cropland classification output



Landsat-5 TM

Resourcesat-1 AWiFS

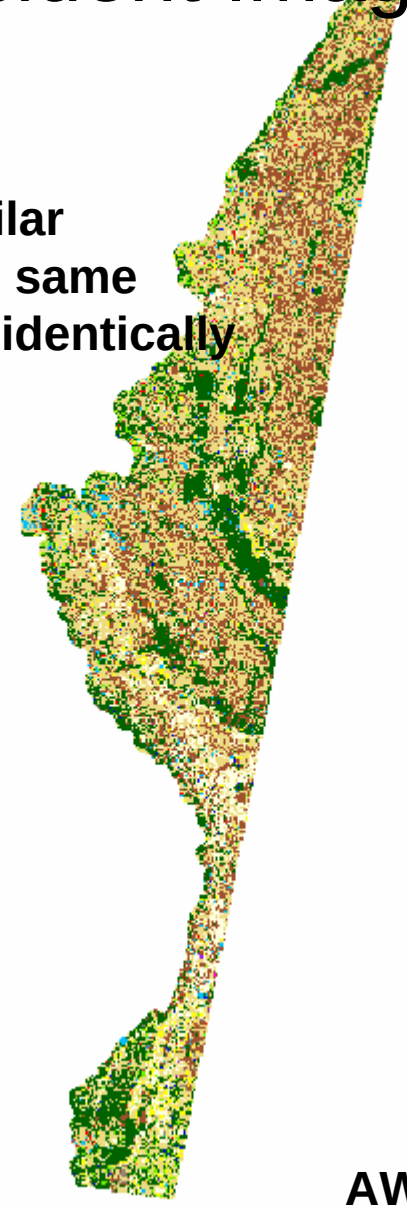
Cropland Mapping with Coincident Imagery



Overall maps are similar

- **General patterns are the same**
- **73.5% of area classified identically**

Corn
Cotton
Rice
Sorgum
Soybean
Winter Wheat
Wheat/Soybean Double Crop
Fallow
Aquaculture
Pasture
Woodland
Urban
Water



Landsat TM

AWiFS

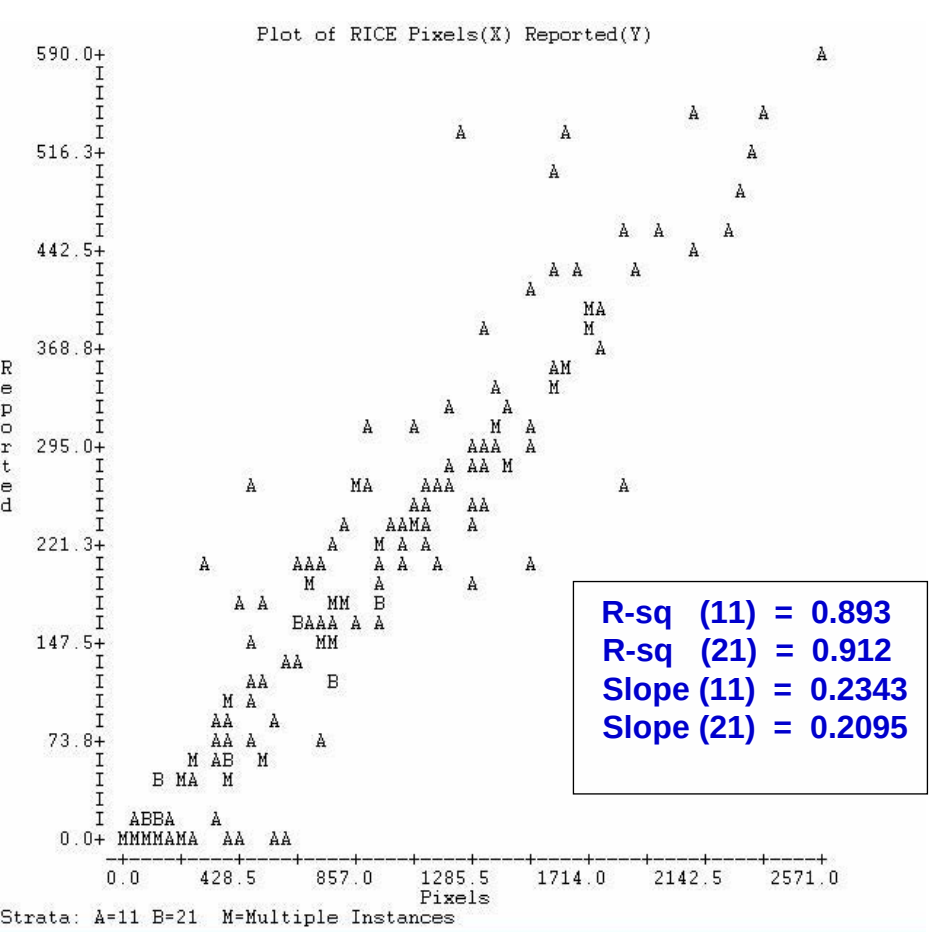
Kappa Statistics for Classifier Accuracy
Landsat TM and AWiFS Coincident imagery

	Landsat TM	AWiFS
Corn	.839	.933
Cotton	.901	.896
Soybeans	.949	.958
Sorghum	.392	.686
Rice	.940	.959
Other Crop	.180	.246
Non Crop	.805	.866
Overall	.889	.918

Kappa Statistics based on June Area Survey (JAS) ground truth data

Regression Analysis from Sample Estimation

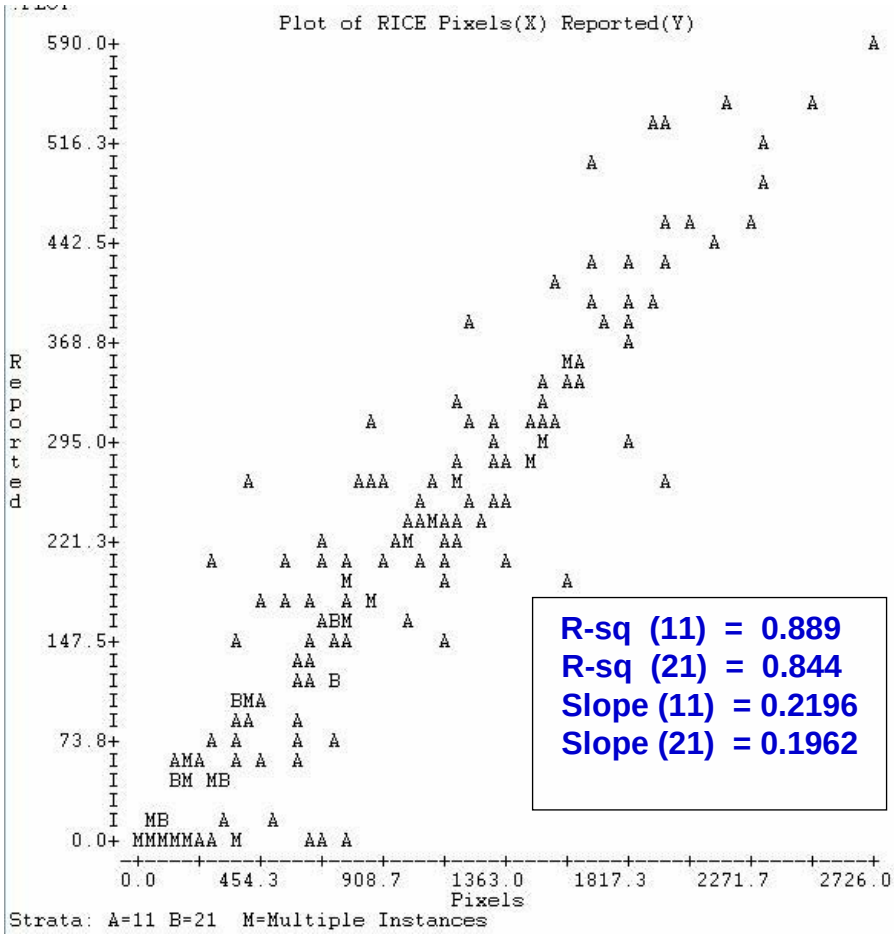
Landsat TM Rice



R-sq (11) = 0.893
R-sq (21) = 0.912
Slope (11) = 0.2343
Slope (21) = 0.2095

Pixel Sq meter/acres- .2224

AWiFS Rice



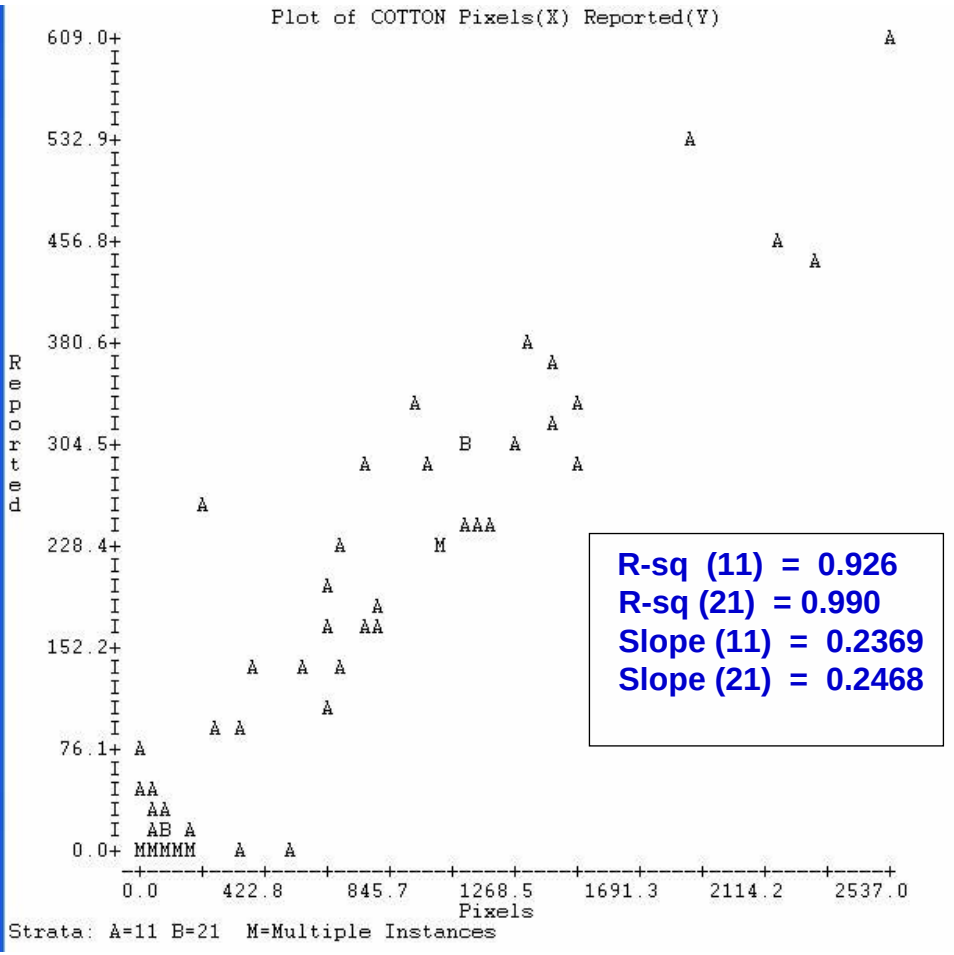
R-sq (11) = 0.889
R-sq (21) = 0.844
Slope (11) = 0.2196
Slope (21) = 0.1962

Pixel Sq meters/acres - .2224

No Outliers Removed

Regression Analysis from Sample Estimation

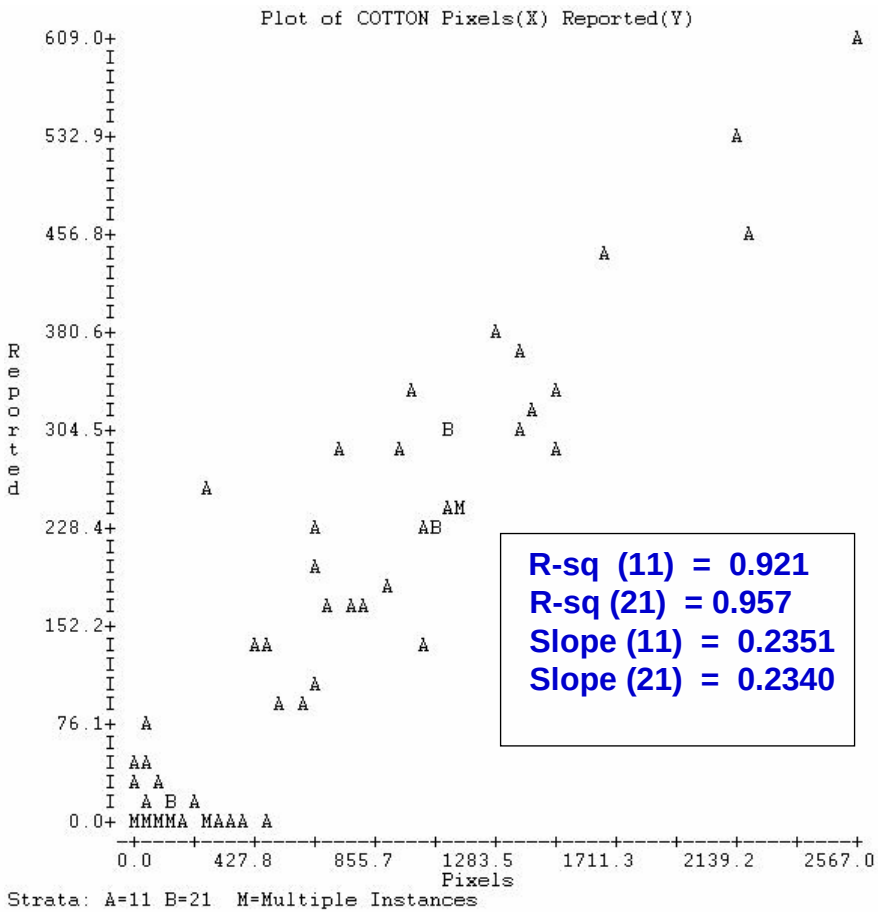
Landsat TM Cotton



R-sq (11) = 0.926
R-sq (21) = 0.990
Slope (11) = 0.2369
Slope (21) = 0.2468

Pixel Sq meter/acres- .2224

AWiFS Cotton



R-sq (11) = 0.921
R-sq (21) = 0.957
Slope (11) = 0.2351
Slope (21) = 0.2340

Pixel Sq meters/acres - .2224

No Outliers Removed

Classification Accuracy Estimates

Overall

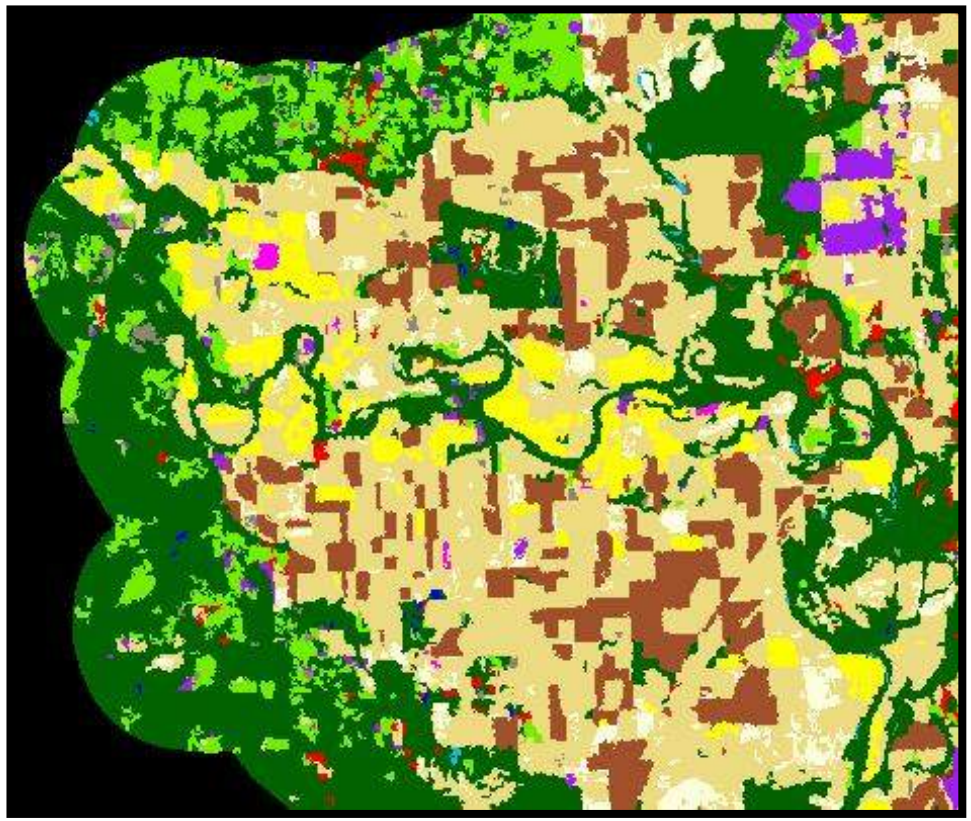
TM = 67.9%

AWiFS = 63.8%

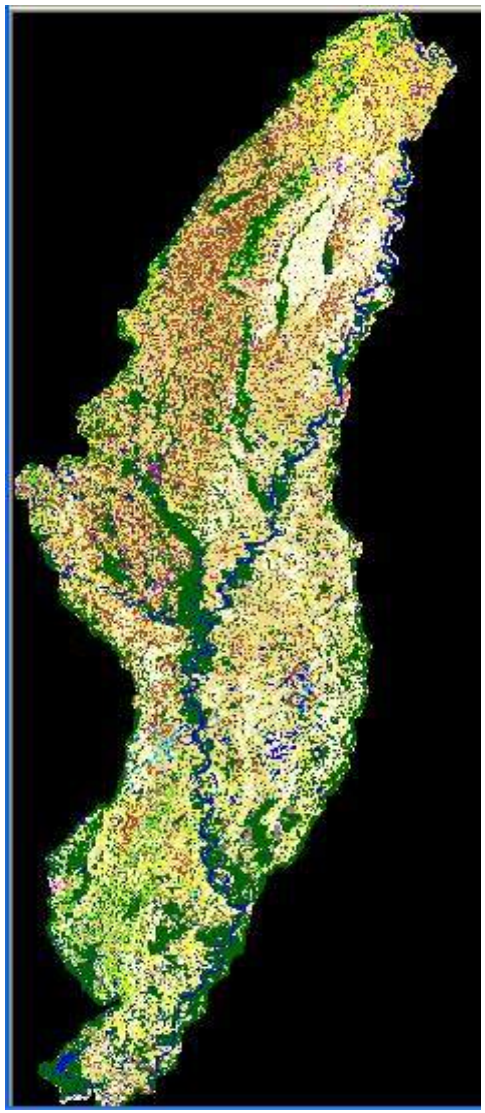
Cropland Only

TM = 76.3%

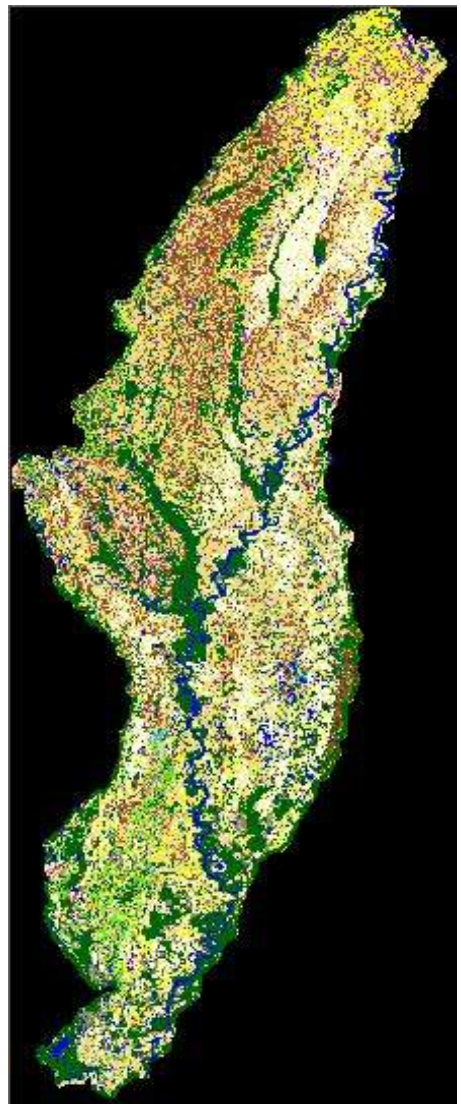
AWiFS = 74.3%



Multitemporal Landsat TM and AWiFS Classifications of the Mississippi River Delta, 2005



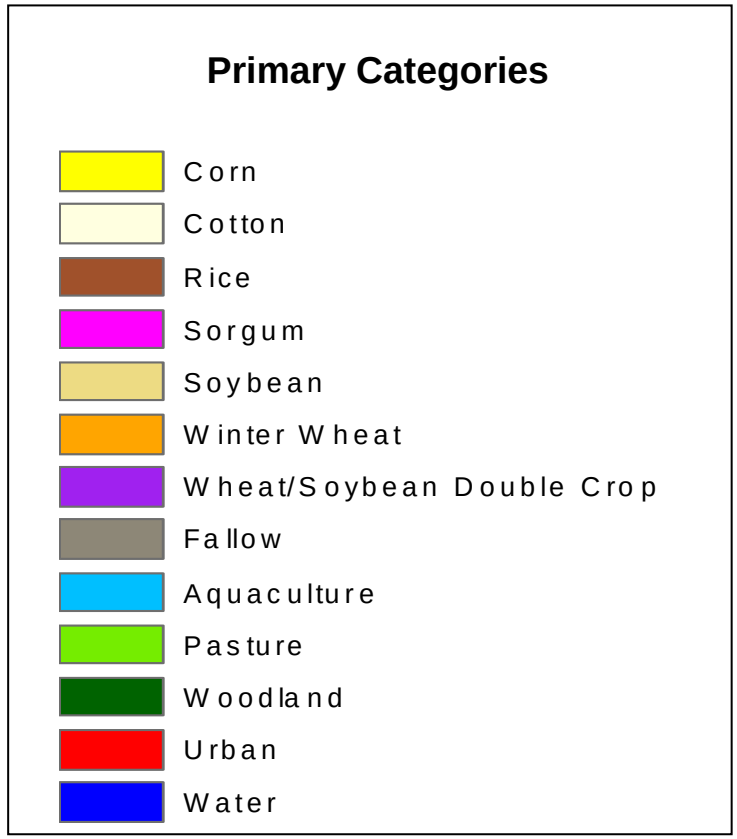
Landsat-5 TM



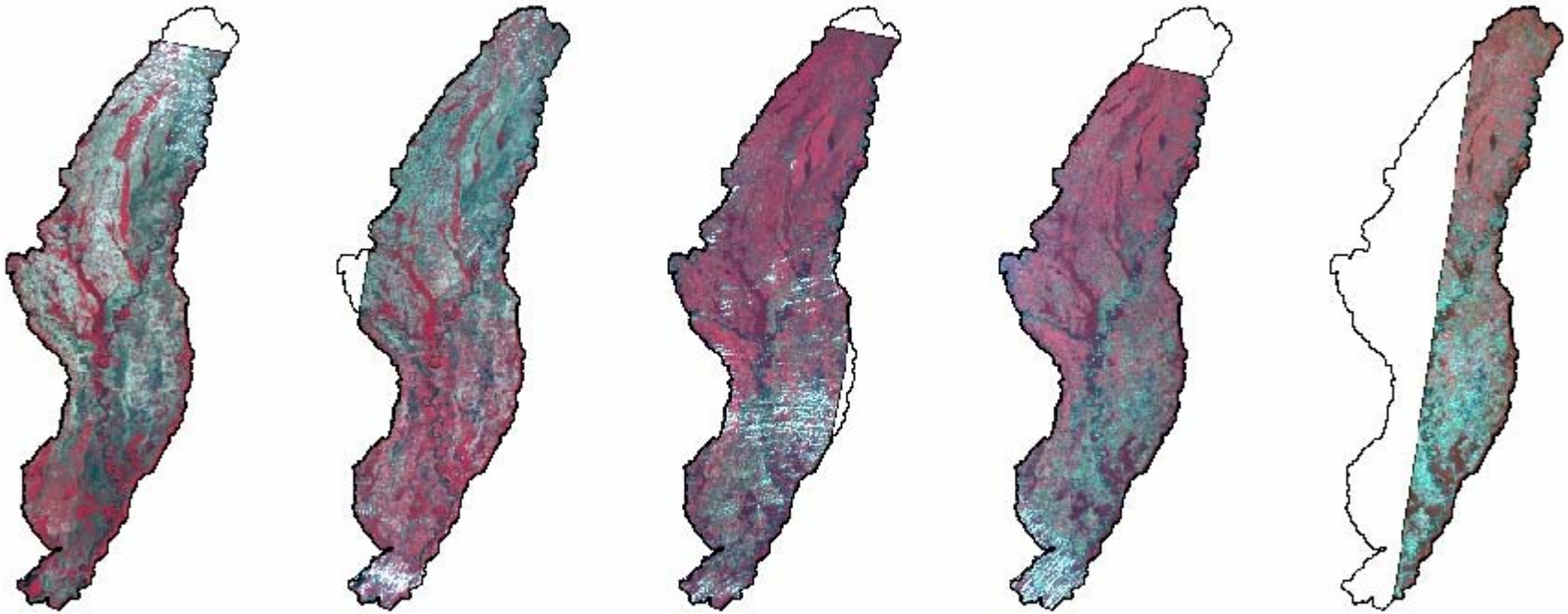
AWiFS

Multitemporal
Landsat TM and AWiFS cropland classifications

- All Imagery clipped to Zone 45: NLCD
- TM imagery analyzed at 30m
- AWiFS imagery resampled to 30m
- 5,000 (approx) randomly distributed polygons (280,000 acres) used for ground truth from JAS survey
- Classification tree analysis (See5) performed
- Minimum mapping unit of 5 pixels applied



AWiFS Time Series 2005

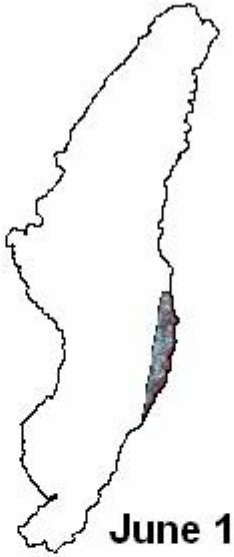


April 27 June 19 August 20 September 3 September 4

Landsat 5 Time Series 2005

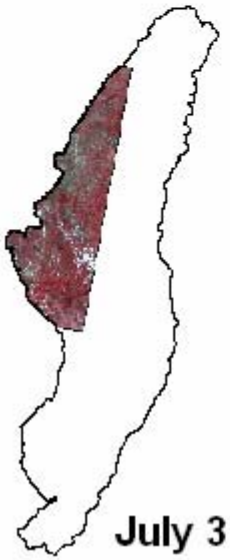
April 14

May 25

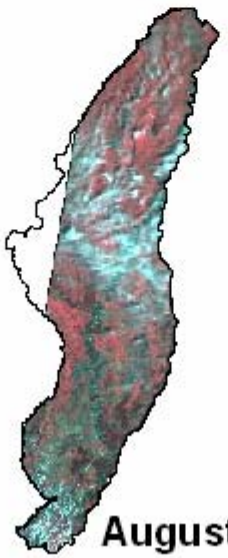


June 19

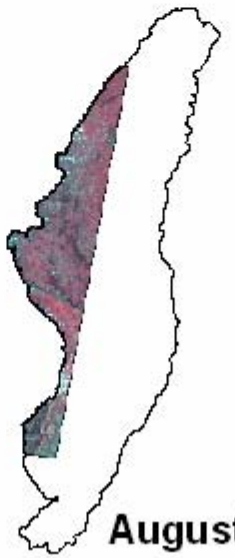
June 26



July 3



August 13



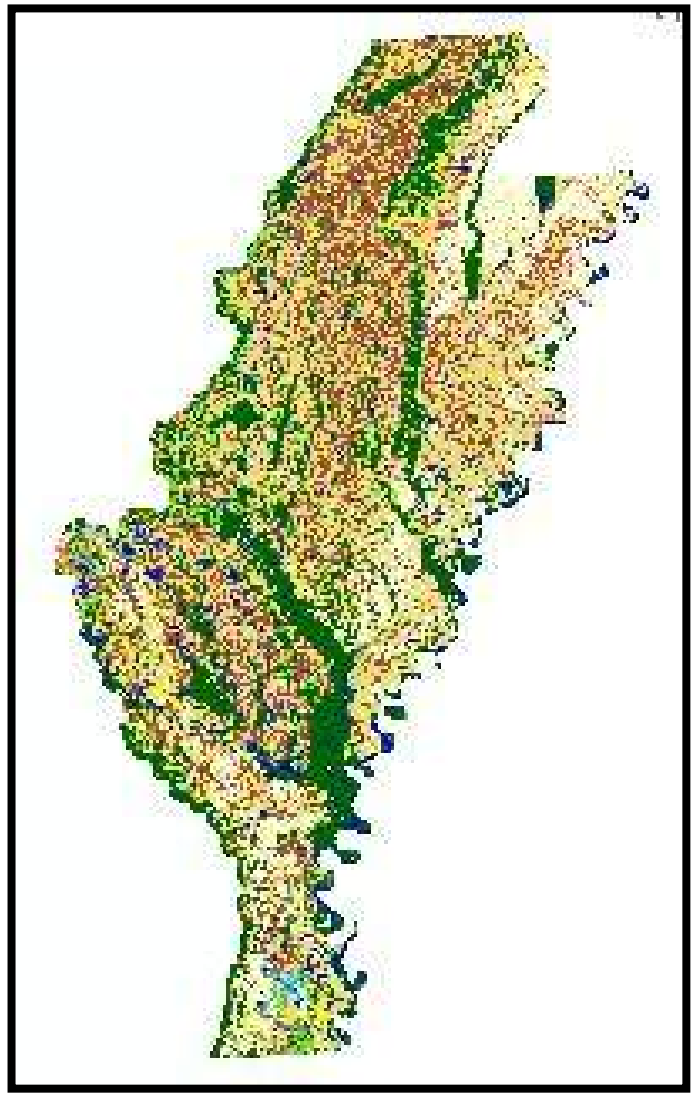
August 20

September 5

Kappa Statistics for Classifier Accuracy Arkansas Region of Mississippi River Delta

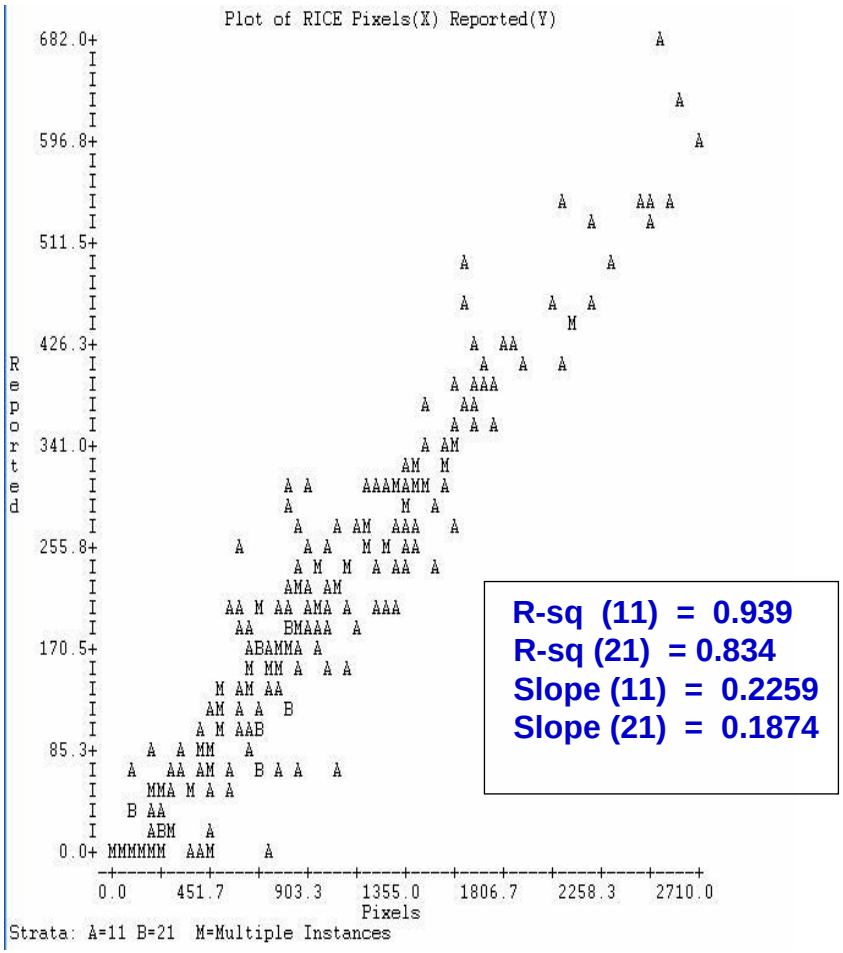
	Landsat TM	AWiFS
Corn	.986	.985
Cotton	.990	.992
Soybeans	.978	.979
Sorghum	.953	.963
Rice	.979	.981
Other Crop	.793	.782
Non Crop	.629	.670
Overall	.917	.925

*** Kappa Statistics based on June Area Survey (JAS) ground truth data**



Regression Analysis from Sample Estimation

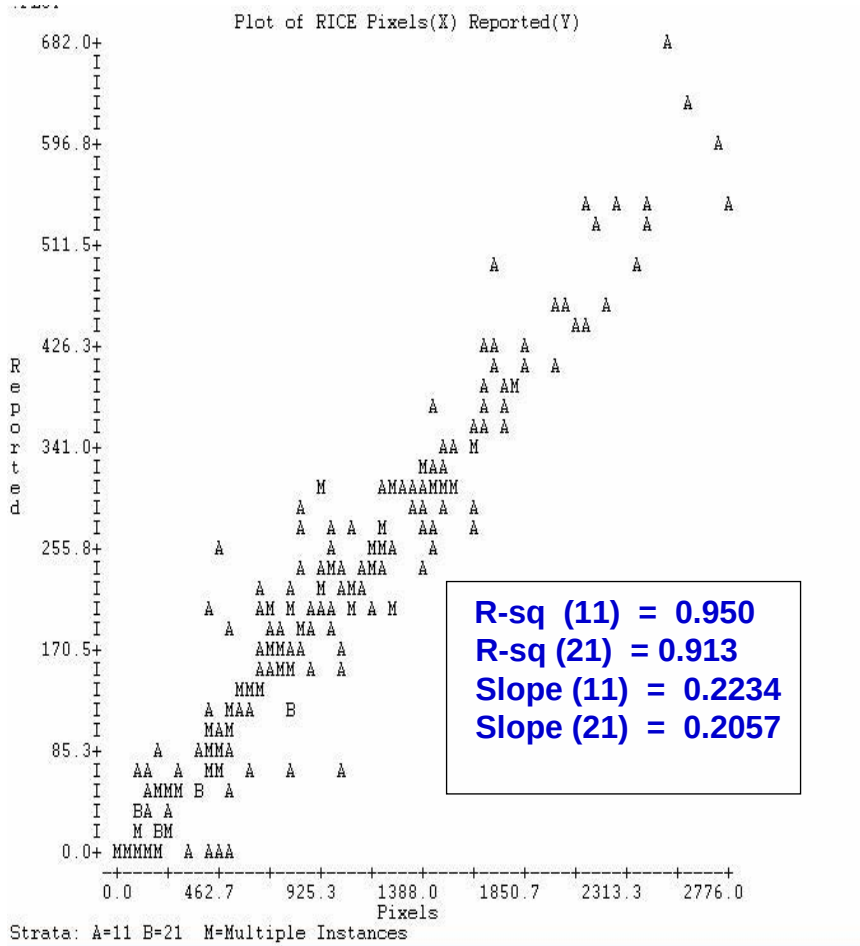
Landsat TM Rice



R-sq (11) = 0.939
R-sq (21) = 0.834
Slope (11) = 0.2259
Slope (21) = 0.1874

Pixel Sq meter/acres- .2224

AWiFS Rice



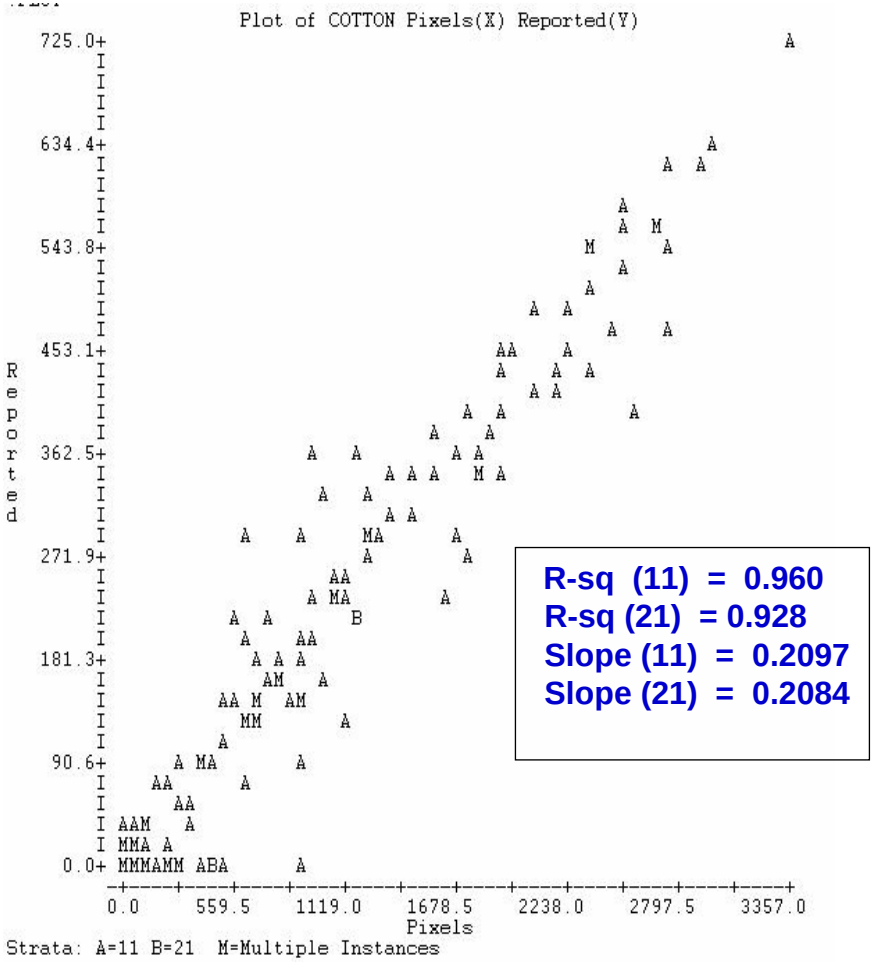
R-sq (11) = 0.950
R-sq (21) = 0.913
Slope (11) = 0.2234
Slope (21) = 0.2057

Pixel Sq meters/acres - .2224

No Outliers Removed

Regression Analysis from Sample Estimation

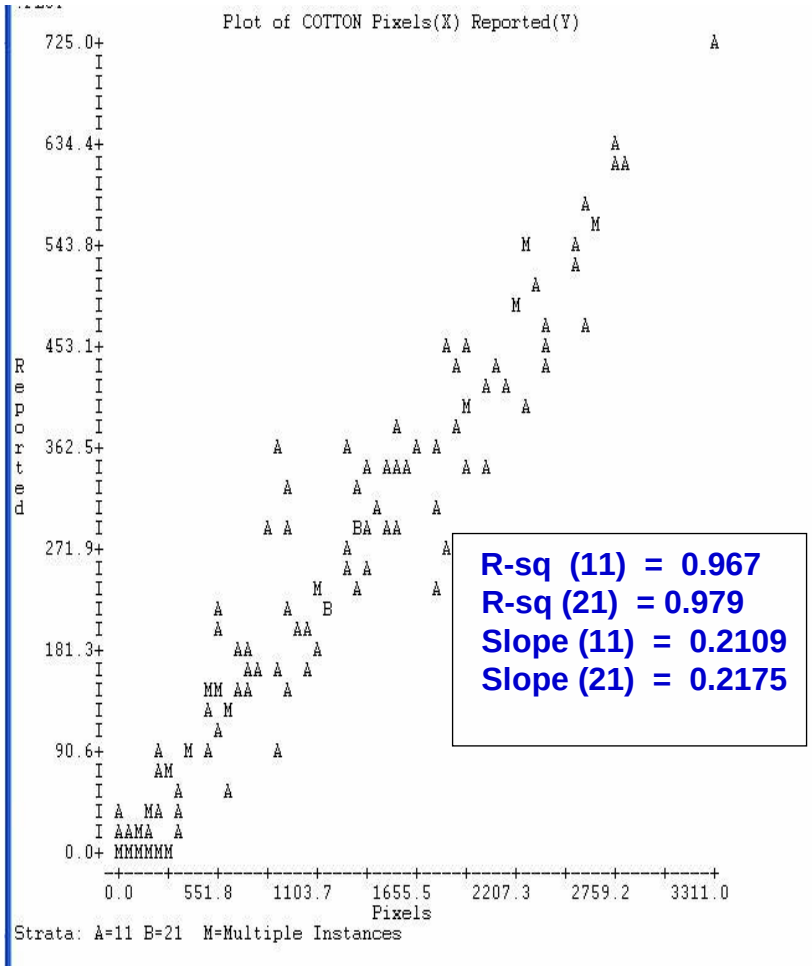
Landsat TM Cotton



R-sq (11) = 0.960
R-sq (21) = 0.928
Slope (11) = 0.2097
Slope (21) = 0.2084

Pixel Sq meter/acres- .2224

AWiFS Cotton

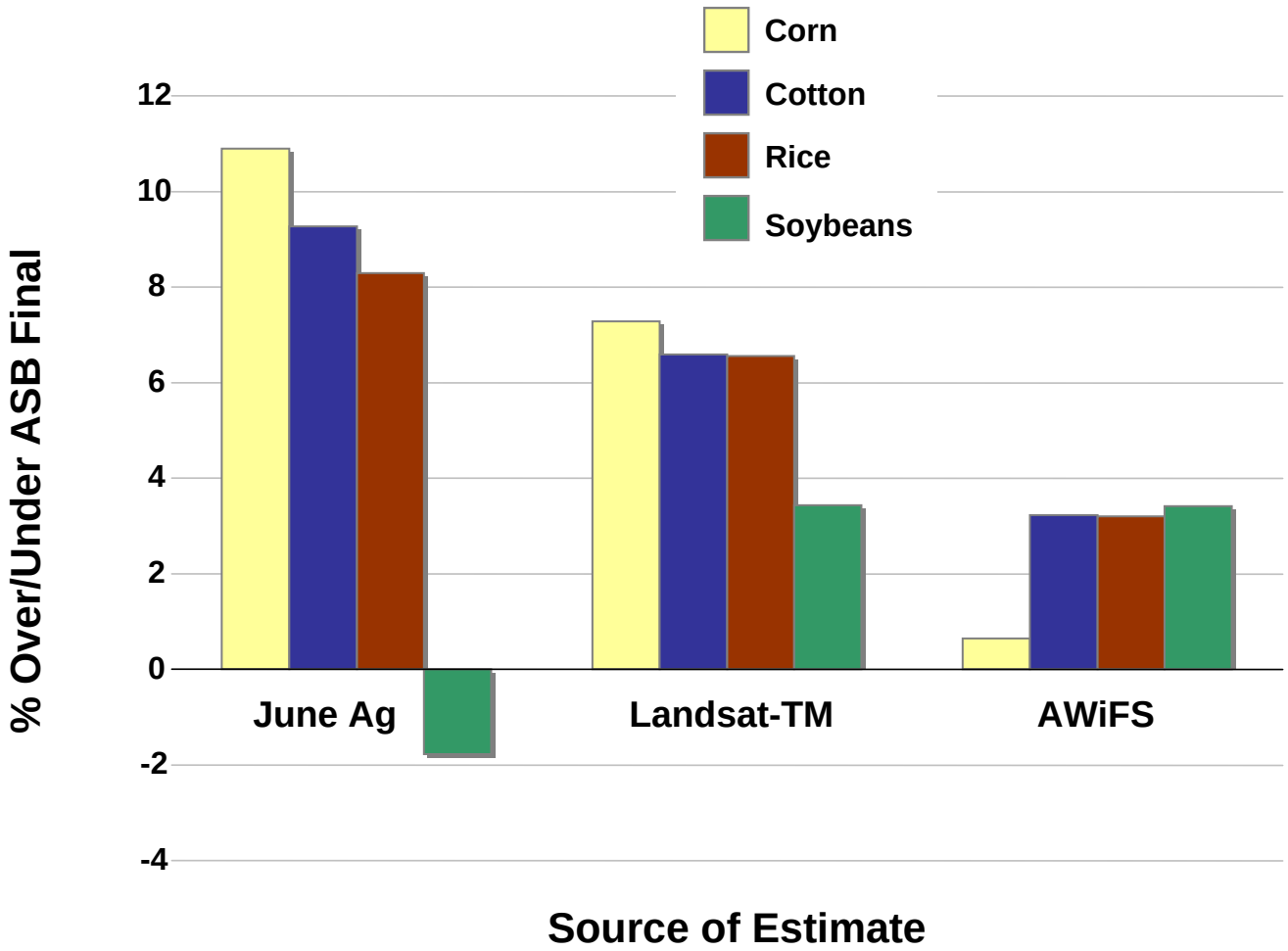


R-sq (11) = 0.967
R-sq (21) = 0.979
Slope (11) = 0.2109
Slope (21) = 0.2175

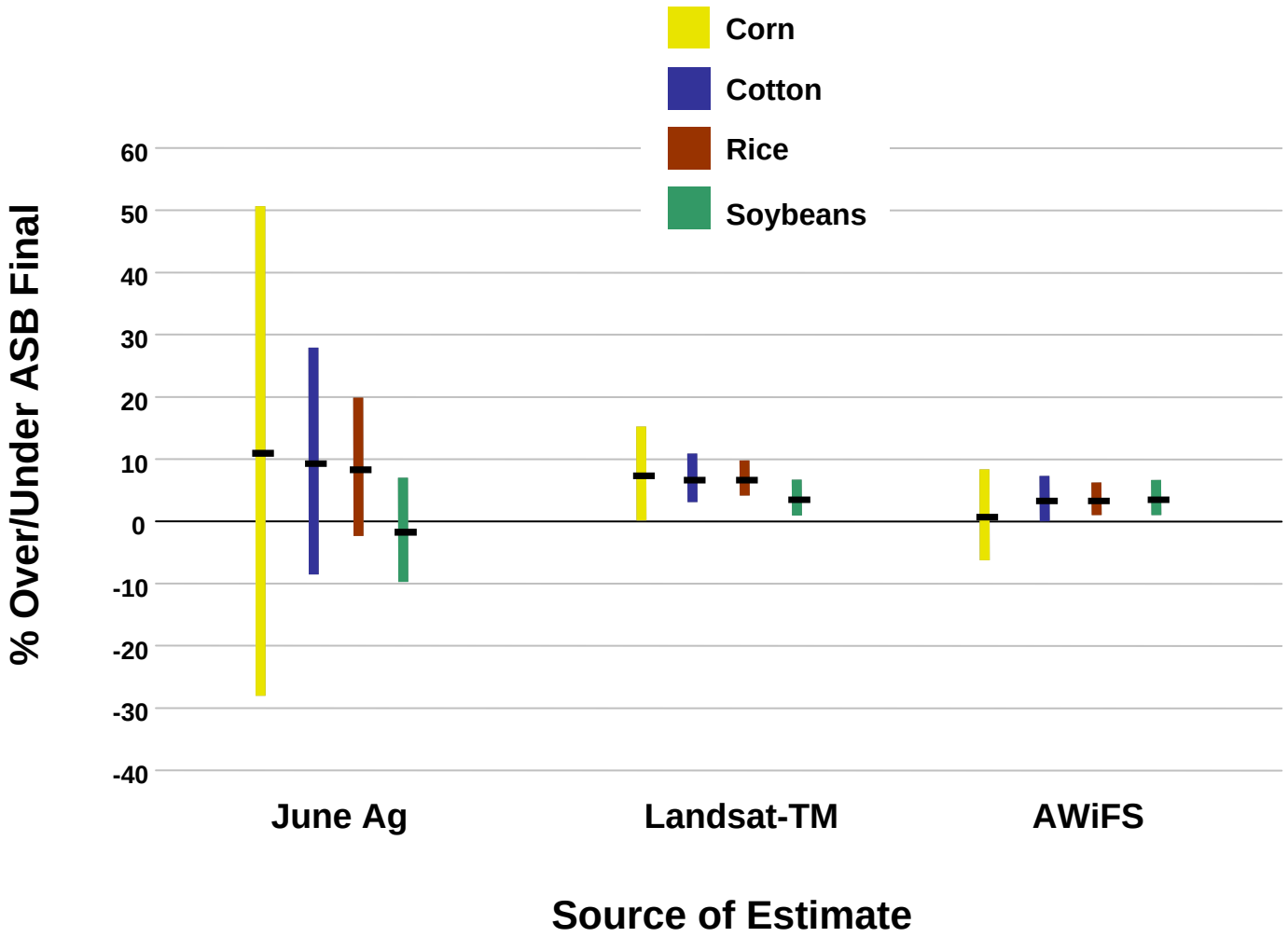
Pixel Sq meters/acres - .2224

No Outliers Removed

Arkansas State Level Estimates as % Over/Under Agricultural Statistics Board (Final)



Arkansas State Level Estimates +/- 2 CV



Conclusions

AWiFS data are appropriate for crop acreage estimation over large, spectrally homogenous, crop areas such as the Mid-West, the Delta and the Northern Great Plains

Regression and Kappa statistics for soybean, corn, cotton, rice and sorghum produced using both the Landsat TM and AWiFS data were very similar.

AWiFS data appear to be a suitable alternative or supplement to Landsat TM data for production of NASS' Cropland Data Layer product.